Human trust: Testosterone raises suspicion

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In his autobiography, Mark Twain recalls his boyhood love of abducting live bats from a local cave and installing them in his coat pocket. Arriving home, he would trick his poor mother, whom he described as full of trust and confidence: "When I said, 'There's something in my coat pocket for you,' she would put her hand in. But she always took it out again, herself; I didn't have to tell her." Evolutionary psychologists might posit that women have been selected for nurturing qualities, which might include a warm, trusting nature such as afflicted Twain's mother. Selection probably would not involve the evolution of separate genes found only in females or in males but rather genes that are present in both sexes but are more likely to be expressed in one sex than the other. Thus, there has been a good deal of interest in the idea that hormones that are more prevalent in one sex could modulate genes to engender sex differences in behavior. For trust and cooperativity, one particular hormone—the peptide oxytocin—has been implicated in several studies (1–3). This peptide is specifically released during childbirth, lactation, and orgasm, so it is in greater circulation in women than in men in at least some contexts and does seem to promote more trusting behavior (2). In PNAS, Bos et al. (4) pinpoint another hormone that may modulate interpersonal trust, but in the opposite direction: testosterone (T). They report that providing this steroid hormone to women reduces their interpersonal trust, specifically how trustworthy they rated strangers based on facial photographs.

What is especially intriguing is that the T treatment, 0.5 mg infused as liquid under the tongue, had this effect of reducing trust only in some of the women. When the 24 subjects were divided into the dozen who were most trusting when given placebo and the dozen who were least trusting, it was only the more trusting women who showed any response to androgens. Women who were already skeptical in their judgment of trustworthy faces did not change their judgment under the influence of T. Rather, it was the 12 women who gave the highest ratings of trust under placebo who became significantly more skeptical after T treatment.

The study is well designed, as the authors use a double-blind, placebo-controlled procedure, so neither the subject nor the experimenter working with her knew whether she had gotten T or a placebo. This

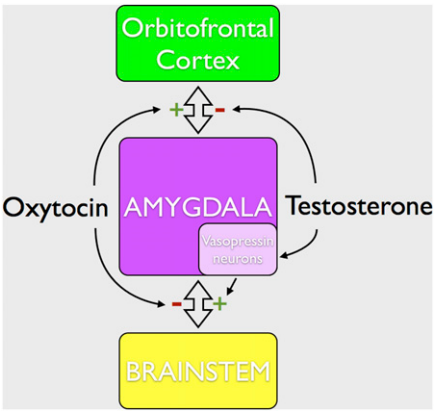

Fig. 1. Potential model for hormonal effects on interpersonal trust. The amygdala (center) is active during fearful responses or detecting threat in faces, and many neurons there possess androgen receptors, enabling them to respond to T. Bos et al. (4) suggest that T may reduce interpersonal trust by acting on vasopressinergic neurons in the amygdala to increase communication to brainstem systems that activate fearful responses, while reducing communication to orbitofrontal cortex. Oxytocin boosts interpersonal trust, perhaps by exerting opposing effects on these same systems.

is an important consideration because other groups have found that women who think they are receiving T, whether they actually do or not, behave more unfairly in a bargaining task, whereas among women who are unaware of whether they receive T or placebo, those receiving T actually behave more fairly (5). Also, Bos et al. (4) use a within-subjects design, meaning that each woman rated the trustworthiness of unfamiliar faces twice, first after receiving one type of infusion (either T or placebo) and again 3 d later after receiving the other type of infusion. On the one hand, this repeated-measures design offers an excellent control for many other sources of variance, including heritable factors, socioeconomic status, and prior experience among others, so the experiment should be very sensitive to any effects of T on trust. However, precisely because even very subtle effects of T can be detected, these findings do not suggest we could make accurate predictions about any particular woman's tendency to trust based on her circulating levels of T. The field has learned this important lesson many times before. The oldest version was the finding that, although eliminating T entirely through castration abolishes male copulatory behavior in many species, among gonadally intact males, there is no correlation between circulating T and sexual vigor. Therefore, despite the ability of exogenous T to reduce trust in the naive women in this study, we would not expect Lucrezia Borgia to have had higher circulating levels of T than Mother Teresa. Indeed, the authors found no correlation between baseline measures of salivary T and their subjects' tendency to rate faces as trustworthy.

These infusions of sublingual T in women raise circulating levels of the hormone 10-fold within 15 min, but levels should return to baseline within 2 h. Because the exogenous hormone was available for only a short time, perhaps its effect on trust was also short-lived, but for now, the time course of exogenous T effects on trust is unknown. Because endogenously produced T levels normally vary across time, these findings also raise the question of whether fluctuating androgen secretion may normally modulate a person's judgment of whether to trust people. There are circadian rhythms in T secretion, in both men and women, so is there also a circadian rhythm in how they judge trustworthiness in faces? There is also variation in circulating T in women across the menstrual cycle, with a modest peak in circulating T just a few days before ovulation (6), the very period during which copulation is most likely to result in pregnancy. What's more, androgens such as T have been reported to boost women's libido in several studies (7–9), including one study using the same sublingual dose of T, which increased sexual arousal (10). If androgens normally boost female libido, a peak in T before ovulation makes sense to evolutionary psychologists who might expect women to be most interested in sex when they are most fertile. What the present findings suggest is that women might also reach their peak in skepticism about the trustworthiness of other people, presumably including potential mates, at about this same point in the ovulatory cycle. Heightened skepticism about a potential mate's trustworthiness also makes evolutionary sense in scenarios where a father's ongoing support is crucial for survival of the infant. In those circumstances, misjudging a man's commitment to help raise joint offspring may result in catastrophe. Despite the many studies

Author contributions: R.T.J. and S.M.B. wrote the paper.

The authors declare no conflict of interest.

See companion article on page 9991 in issue 22 of volume 107.

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examining fluctuations in cognitive functions in women across the menstrual cycle, including changes in preferences for self-resembling faces (11) and for femininity in faces (12), it is not clear whether anyone has examined how women's ratings of trustworthiness of unfamiliar faces vary across the menstrual cycle. Do those ratings decline just before ovulation? Does an androgen-fueled bump in skepticism before ovulation make women more cautious when evaluating a handsome stranger (13)?

Another question is where T may be acting in the brain to affect trust. Bos et al. (4) point out that the amygdala has been implicated in many studies of social judgment, including making judgments about other people's faces, and it is also a hotspot for neurons expressing the androgen receptors that T acts upon to regulate gene expression (14, 15). Thus, it is possible that T may alter social judgments by acting directly on the amygdala, perhaps, the authors suggest, by regulating the strength of signaling between the amygdala and other brain regions implicated in social evaluation, such as the orbitofrontal cortex (Fig. 1). It will be interesting to see where oxytocin and T might interact as they exert their opposite effects on ratings of trustworthiness in others.

For that matter, we are in the midst of a boom of studies manipulating various hormones to look for effects on social judgment, so we may expect other hormones to join the fray, which would expand the interactions beyond just oxytocin and T. Of course, social context and past experience also normally affect how naive we are when judging others. However, some people never seem to learn. Twain reports that his mother fell for that "surprise" in his coat pocket more than once: "It was remarkable, the way she couldn't learn to like private bats. The more experience she had, the more she could not change her views." Apparently, Twain's mother was exactly the type of woman who might have benefitted from a judicious dose of T when weighing her son's words.

ACKNOWLEDGMENTS. Support for this work was provided by National Institute of Mental Health Grant F31MH084655 (to R.T.J.), National Institutes of Health Grants R01NS028421 and R21MH082273, and National Science Foundation Grant IOS0956831 (to S.M.B.).

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